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The Use of Radioactive Chromium Oxide in Digestibility Determinations[1/]

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The present investigation was undertaken to determine the efficiency and feasibility of using radioactive chromium oxide as an indicator in digestibility studies with ruminants. The plan of the experiment was a series of digestion trials in which digestibility coefficients obtained by radioactive techniques would be compared with digestibility results gained by such standard methods as total collection and chromium oxide ratio technique.

Three cows were fed rations of alfalfa hay, and alfalfa hay plus starch. The alfalfa hay was a graded U. S. No. 1 and the starch was a commercial corn starch (Amazo). Daily supplements of 100 g. steamed corn meal and 50 g. salt were also provided. Chromium oxides $Cr_2{}^{51}O_3$ and Cr_2O_3 were administered by capsule.

Chromium oxide in the form of a fine powder was sent to Oak Ridge National Laboratories for irradiation in a pile and partial conversion to chromium ^{51} oxide. When returned to Beltsville the irradiated chromium oxide had a specific activity of 33 millicuries.

In applying radioactive techniques to digestibility studies it is not necessary to know the absolute amount of radioactivity used. The relative activity of the dry matter intake and the fecal dry matter output is all that is required for the measurement of dry matter digestibility. This relation can be determined by using samples of infinite thickness which are samples of sufficient depth so that radiation from the bottom layer is not detected by the counting instrument. Under the conditions of this experiment 4 g. of material was found to form a sample of inifinite thickness. Since all samples were of the same size the depth the readings in the counter were proportional to the radioactivity in the samples.

Alfalfa hay standards were made by adding mixtures of diluted $Cr_2{}^{51}O_3$, (for example $Cr_2{}^{51}O_3$ - 1 part, Cr_2O_3 - 9 parts, Wheat Flour - 70 parts) to dried and ground alfalfa hay at the rate of 4 mg. of the radioactive mixture per gram of alfalfa hay.

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In determining digestibility by means of radioactivity the following formula was used:

$$\text{Dry matter Digestibility} = 100\left(\left(1 - \frac{\text{c/s/mg } Cr_2{}^{51}O_3 \text{ in Alfalfa Std. X mg } Cr_2{}^{51}O_3 \text{ Fed/g Feed}}{\text{c/s/g Feces}}\right)\right) =$$

c/s/g = counts per second per gram

Results and Discussions:

The Chemical analysis of the hay and starch fed are reported in Table 1. Starch data is from Morrison.

Table 1 - Chemical composition of rations fed (% Dry Matter)

Ration Constituent	Period	Protein	Ether Extract	Ash	Crude Protein	NFE
Alfalfa Hay	I	17.6	1.48	7.34	25.7	47.8
Alfalfa Hay	II	17.7	1.34	7.41	26.4	47.1
Alfalfa Hay	III & IV	17.4	1.46	7.24	27.2	46.8
Starch	II & IV	0.6		0.20	0.2	99.1

In Period II the daily fecal samples were composited and the radioactivity of the composite samples determined. Average period readings for cows 280, 293, and 647 were 2.54, 2.39 and 2.83 counts per second respectively. These readings, after correction for amounts of non-hay indigestible residues in feces, became the denominator used in the digestibility formula above.

In Periods III and IV a study of the variation in the daily excretion of the radioactive isotope was made. This was done in the preliminary period as well as in Period III and IV. Figure 1 is a chart delineating the daily variation of radioactivity found in the feces of the three cows.

In Table 2 the apparent dry matter digestibilities obtained by the three methods are reported. Statistical analyses showed no significant differences between digestibility coefficients obtained by the radioactivity method and those obtained by either the standard total collection method or chromium oxide ratio techniques. Thus, the results indicate that satisfactory digestibility coefficients can be obtained by the use of radioactive chromium oxide.

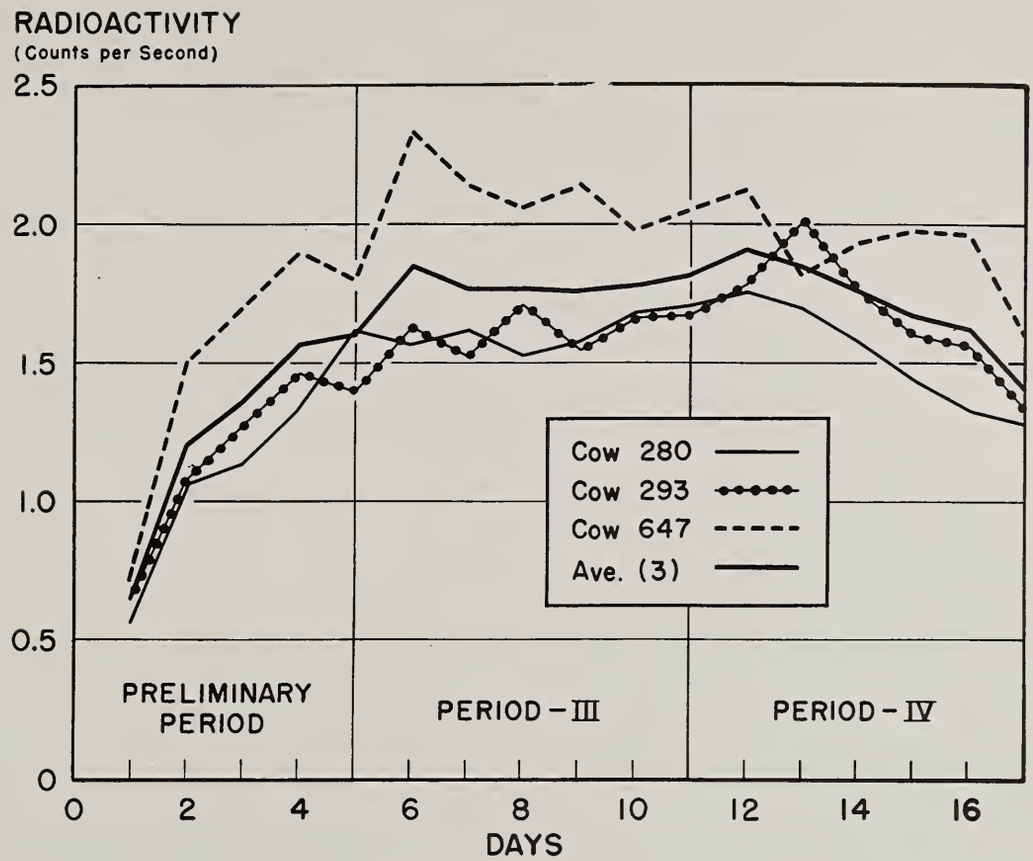

Figure 1 - Daily Variation in Radioactive Chromium Oxide Excretion

Table 2 - Dry Matter Digestibilities Obtained by Different Methods

Period	Method	Cow 280	Cow 293	Cow 647	Ave.
I	Total Coll.	60.1	60.2	60.2	60.2
II	Total Coll	60.2	58.8	60.4	59.8
II	Cr_2O_3	59.3	----*	----*	59.3
II	$Cr_2{}^{51}O_3$	64.1	61.8	58.1	61.3
III	Total Coll.	61.1	61.2	60.8	61.0
III	Cr_2O_3	61.9	63.2	60.0	62.0
III	$Cr_2{}^{51}O_3$	61.5	61.8	61.1	61.5
IV	Total Coll.	58.2	55.5	59.1	57.6
IV	Cr_2O_3	59.8	57.5	59.6	59.0
IV	$Cr_2{}^{51}O_3$	59.1	59.3	55.4	57.9

* Cows 280 and 647 had muzzles covered with a green substance on day fed for this day's feces. Digestibilities were abnormally low and discarded. It is suspected that these cows coughed up some of the chromium oxide administered.

The experimental animals although observed closely throughout the experiment showed no evidence that the exposure to radioactive substances had effected them in any way. Samples of milk and urine from cows that were receiving radioactive chromium oxide had about the same activity as milk and urine from cows not receiving radioactive isotopes.

Conclusions:

1. Radioactive chromium oxide appears to be a reliable indicator for use in determining digestibility.

2. The use of radioactive chromium oxide in digestibility studies affects a saving of time and labor.

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